

PRELIMINARY DESIGN OF CRYOGENIC HYDROGEN RADIATION SHIELD FOR HUMAN SPACE FLIGHT

Completed Technology Project (2013 - 2014)



Project Introduction

Hydrogen is the most mass-efficient radiation shielding material for protection against the space radiation environment. The concept of Cryogenic Hydrogen Radiation Shielding (CHRS) was studied by Cryogenic Branch at NASA GSFC with a FY08 IRAD. This IRAD project will complete a preliminary thermal and ground cooling system design of the CHRS system and also perform a radiation transmission test with potential CHRS tank materials.

The objectives of this IRAD study are to perform the preliminary thermal system design and optimization of the CHRS system and to perform radiation testings of samples of materials that are candidates for containing the hydrogen in the CHRS.

The previous study of the concept proposed a potential CHRS geometry. We can meet the thermal design requirements by using proper cryogenic thermal management techniques. Various design options will be investigated for the fluid management system. The fluid management system will provide the required fluid distribution in the tank, and suppress the formation of large gas bubbles. We will use a Computational Fluid Dynamic (CFD) analysis tool ANSYS FLUENT® to analyze and optimize the performance of the fluid management system.

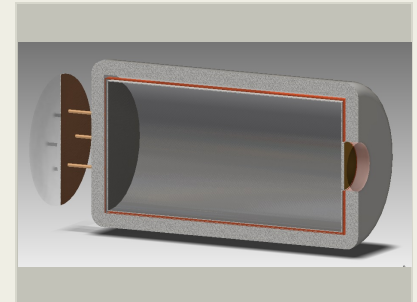
In addition to the work above, the tank materials will be selected based on the thermal performance. The radiation test for these materials will be carried out at NASA Center for Radiation Engineering and Science for Space Exploration (CRESSE).

This FY 2014 IRAD study will increase the CHRS TRL level to 2. The design will prove the concept and increase the feasibility of the CHRS system. The output from this study can be used to pursue research opportunities for the radiation shielding at NASA's Human Research Program (HRP).

Justification

Human susceptibility to the harsh space radiation environment has been identified as being a major hurdle for exploration beyond low Earth orbit (LEO). High energy protons and nuclei ions from Solar Energetic Particles (SEPs) and Galactic Cosmic Rays (GCRs) can result in radiation doses that are dangerous to astronaut health and even survivability if the astronauts are not adequately shielded. The high energy particles also cause significant amounts of secondary radiation when they impinge on Aluminum, which is commonly used for spacecraft structure. The secondary neutron radiation may cause human radiogenic cancers. Hydrogen or hydrogen rich materials are ideal materials for radiation shielding because of hydrogen does not easily break down to form secondary radiation source.

A CHRS concept study was conducted by the Cryogenics and Fluids Branch in FY08. The results showed the most mass effective material for protecting a spacecraft if proper design is implemented. The performance of three



CONCEPT OF CRYOGENIC HYDROGEN RADIATION SHIELDING

Table of Contents

Project Introduction	1
Anticipated Benefits	2
Primary U.S. Work Locations and Key Partners	2
Organizational Responsibility	2
Project Management	2
Images	3
Links	3
Project Website:	3
Technology Maturity (TRL)	3
Technology Areas	3

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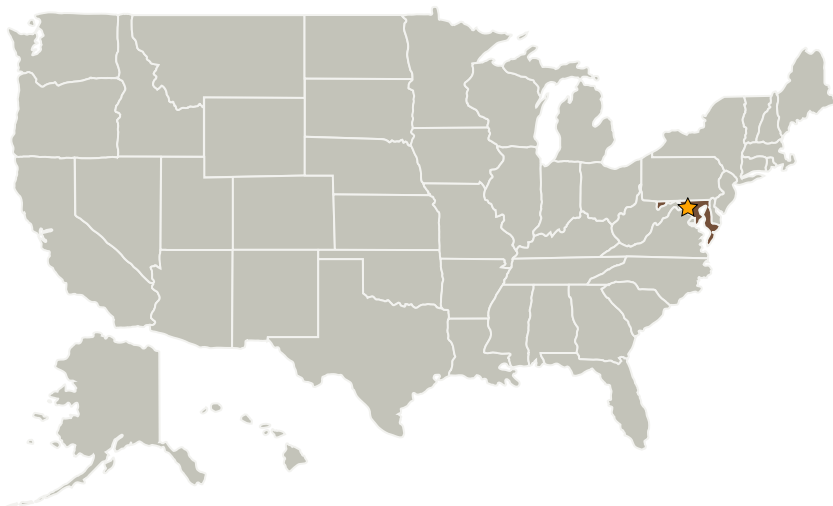
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candidate materials was studied in a LaRC study.

Anticipated Benefits

Human Space flight beyond LEO, including Lunar and Marsian Missions.

Primary U.S. Work Locations and Key Partners

Organizations Performing Work	Role	Type	Location
★ Goddard Space Flight Center (GSFC)	Lead Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations

Maryland

Organizational Responsibility**Responsible Mission Directorate:**

Mission Support Directorate (MSD)

Lead Center / Facility:

Goddard Space Flight Center (GSFC)

Responsible Program:

Center Independent Research & Development: GSFC IRAD

Project Management**Program Manager:**

Peter M Hughes

Project Manager:

Terry Doiron

Principal Investigator:

Xiaoyi Li

Co-Investigators:

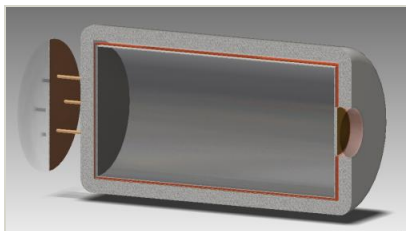
Shouvanik Mustafi
Henry Fitzpatrick

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Images



CRYOGENIC HYDROGEN RADIATION SHIELDING

CONCEPT OF CRYOGENIC HYDROGEN RADIATION SHIELDING
(<https://techport.nasa.gov/image/4215>)

Links

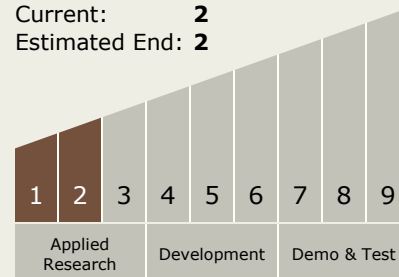
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Project Website:

<http://sciences.gsfc.nasa.gov/sed/>

Technology Maturity (TRL)

Start: **1**
Current: **2**
Estimated End: **2**



Technology Areas

Primary:

- TX06 Human Health, Life Support, and Habitation Systems
 - TX06.5 Radiation
 - TX06.5.3 Protection Systems